CLAIMS

We claim:

1. A System for determining the orientation of the eye consisting of the following sub-systems:

   an x, y high-speed eye tracking system, for measuring the very fast translation or saccadic motion of the eye, relative to an ophthalmic surgical, diagnostic or treatment device or instrument;

   a second position measurement system for measuring slower eye movements, such as multiple dimensions of eye position and / or position of eye parts, relative to an ophthalmic surgical, diagnostic or treatment device or instrument; and

   a system for combining the measurements of the two previous systems for obtaining a multiple dimensional model of the eye position that is more accurate than the model obtainable from either system individually.

2. The system according to claim 1, wherein the x, y eye tracking system is either a multiple imaging device solution in which one imaging device is coaxial to the eye and either one or two off-axis imaging devices capable of selective line readout, or a single high speed imaging device optionally capable of selective line readout, or a LADAR vision eye tracker or a CRP eye tracker.

3. The system according to claim 1 or 2, wherein the second eye position measurement system is a single coaxial imaging device or multiple imaging devices for measuring the eye, or a non-image based depth measurement system.

4. The system according to claim 1, 2 or 3, where the system for combining the measurements obtains the multiple dimensional model of the eye position in order to calibrate one or both of the eye tracking devices, such as set the region of interest, spot location, or scanning limits for the other eye location device; or to provide 3 or more dimensions of eye position.

5. The system according to claim 1, which includes a structured illumination and according filtering means to improve visibility of a unique combination of trackable features.

6. A method for determining the orientation of the eye consisting of the following steps:

   tracking eye movement at a tracking rate that is sufficiently fast to follow the saccadic motion of the eye;

measuring other slower changing positions for the eye or parts of the eye at a slow rate, relative to an ophthalmic surgical, diagnostic or treatment device or instrument; and

combining the measurements of the two previous systems to obtain a multiple dimensional model of the eye position that is more accurate than the model obtainable from either system individually.

7. The method according to claim 6, in which the step of eye tracking is performed by either multiple imaging devices and the use of selective line readout or by a single imaging device and optional selective line readout or by a non imaging based tracking method, such as that used by the LADAR vision system or CRP system.

8. The method according to claim 6 or 7, where the position measurement of other components of eye movement comprises either detecting foreign objects or compensating for pupil offset or measuring torsion or measuring eye rotation or measuring depth or a combination thereof.

9. The method according to claim 6, 7 or 8, which includes structured illuminating and filtering method to improve visibility of a unique combination of trackable features.

10. A system for determining the position of the eye consisting of the following:

a means for making a reference measurement of three or more points on the eye, in three dimensions;

a means for measuring these same reference points at a subsequent time in three dimensions; and

a means for determining the position of the eye from the change in position at these multiple points.

11. A method for determining the position of the eye comprising the following steps:

making a reference measurement of three or more points on the eye, in three dimensions;

measuring the same points at a subsequent time in three dimensions;

determining the orientation from the eye from the change in position at these multiple points.

12. A system for determining the position of the eye comprising the following

a means for tracking the translational eye position;

a means for tracking the translational head position; and

a means for determining the rotation of the eye from the variation of difference between head position and eye position.

13. A method for determining the position of the eye comprising the following steps:

measuring the translational eye position;

measuring the translational head position; and

determining the rotation of the eye from the variation of difference between head position and eye position.

14. A system for determining the position of parts of the eye characterized in that the system comprises:

a means for measuring the offset between the pupil centre and a fixed feature on the eye; and

a means for correcting the output from the fast pupil tracking system on the basis of the measurement of the offset between the pupil centre and a fixed feature on the eye.

15. A method for determining the position of parts of the eye characterized in that the method further comprises:

measuring the offset between the pupil centre and a fixed feature on the eye, and

correcting the output from the fast pupil tracking system on the basis of the measurement of the offset between the pupil centre and a fixed feature on the eye.

16. A system for low latency eye tracking which consists of:

means for selecting relevant lines from an imaging sensor, based on prior knowledge of position of the eye;

means for selectively transferring these lines to a processor; and

means for processing this information to find eye position.

17. A method for low latency eye tracking which consists of:

selecting relevant lines from an imaging sensor, based on prior knowledge of position of the eye;

transferring these lines selectively to a processor; and

processing this information to find eye position.

18. A use of the system according to claim 1, 10, 12, 14 or 16 for the purpose of laser refractive surgery in order to intra-operatively update the pre-programmed shot pattern on the basis of the determined orientation of the eye to correct for eye position and its effect on correction efficacy.

19. A use of the method according to claim 6, 11, 13, 15 or 17 for the purpose of laser refractive surgery in order to intra-operatively update the pre-programmed shot pattern on the basis of the determined orientation of the eye to correct for eye position and its effect on correction efficacy.